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Some studies on the taxonomic status of the genus Aiolopus Fieber (Acrididae : Acridoidea: Orthoptera) from Pakistan

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Abstract

At the present orthopteran fauna in agricultural fields of Pakistan were investigated. The large numbers of specimens have been collected from different provinces of Pakistan during the year 2011-2012. Three species namely *Aiolopus thalassinus thalassinus*, Fabricius, *A.thalassinus tamulus,* Fabricius, and *A.simulatrix simulatrix,* Walker, of subfamily Oedipodinae were came in collection. However, the most dominant and widely distributed species was *Aiolopus thalassinus thalassinus* its distribution has been reported throughout country. Besides this; some important characters of male and female genitalia have also been studied. All above studied species were recognized as severe pest of many valued crops in Pakistan. Present investigation has been carried out for the first time from this region.

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Introduction

The genus *Aiolopus* was proposed (Fieber 1853) with *Gryllus thalassinus* (Fabricius 1781) as the type of species. The genus was revised (Hollis 1868) Who recognized seven species. Whereas at present thirteen species of *Aiolopus* are known Worldwide according to taxonomic position (Eades & Otte 2008). Earlier pioneer workers carried out investigation on characterization of arthropod's fauna i-e (Kirby 1914; Mischenko 1936; Uvarov 1966; Dirish 1975; Ahmed 1980; Ritchie 1981; Wagan 1990; Baloch 2000; Tokhai 1997) on the basis of external characters. Hence the present work was taken on three species from Pakistan. (Cotes 1893; Januja, 1957) reported the damaging status on rice nurseries and on other field crops. The members of this genus pertaining to subfamily Oedipodinae; and they have economic importance in Pakistan. The species are widely distributed from agriculture range land to semi deserted regions in country. In the current study attention was paid to recognize the male and female genitalia characters; that play an important role for taxonomic purpose. This genus is closely related to *Platypygius* Uvarov in having general shape and the spurious median of the tegmina is close to M in the apical part but can easily be separated from the same in having elongated fastigium, fastigial foveolae elongated trapezoidal and male sub-genital plate is bluntly conical and by the other characters as noted in the keys and description. A key for the separation of species was prepared on the basis of easily recognizable characters is given here. The fascinated feature of the species was seen at the survey of field; that the grasshoppers were feeding voraciously on the leafy parts of plants. Mean while they may cause serious infest on crops. On other side to update the knowledge of *Aiolopus* of Pakistan this work shows the great value of diagnostic features of Phallic complex and epiphallus, in addition the size and shape of ancorae and space between the lophi were considered as authentic character for the purpose of taxonomic study, as well as a tool for the sake of accurate identification. In spite of this the distribution of the genus in Pakistan may be considered, because it was observed during the field study that in favorable climatically conditions when their numbers may be increased, they pose threat to agricultural crops. Furthermore, and these investigations may be proved helpful for ecologists, entomologists and for agriculturalists to solve the pest problems.

Materials and methods

Field Survey

The adult grasshoppers were collected from agricultural fields, open grasses, herbs and shrubs and semi deserted areas of Pakistan with the help of standard entomological net. The collections were made as monthly intervals during the year 2011-12. The large number of specimens was collected; that processed as the basis for taking the present study.

Laboratory Study

The following method has been adapted from (Vickery & Kevan 1983). Specimens were killed by potassium cyanide in standard entomological bottles. The pinning of specimens was made within few hours as the specimens were flexible; and that the parts could be stretched as desired. The fully dried specimens were removed from stretching boards and were stored in standard entomological boxes with labels showing locality, date of collection and collector name. Naphthalene balls were placed in boxes to prevent the specimens from the attack of ants and other insects. For the study of male genitalia (Kevan et al., 1961) method was adopted. After relaxing supra-anal plate of the specimen was raised smoothly with the help of needle cut laterally and whole phallic complex was taken out.

Process of Dissection

The phallic complex was immersed in 10% hot potassium hydroxide solution for 5to 10 hours in order to remove unsclerotized and non chitinous tissues. The collected specimens were identified through the works of (Kirby 1914; Chopard 1969) and by consulting named collections in the Sindh museum (Orthoptera cabinet) in the department of Zoology

University of Sindh Jamshoro Pakistan. For the study of female genitalia method was used as reported (Randell 1963). After relaxing the insect as per method mentioned above with the help of fine scissors an incision was made on each side of the abdomen where the tergum meets the sub genital plates, and continued for enough anteriorly to allow removed of the extra plate in the neat operation. The sub genital plate was then depressed with forceps and a third cut made at its base were removed with the sub genital plates**.** The spermatheca lies just above the vagina was also removed. The dissected sub genital plate and spermatheca was then washed with 10 % potassium hydroxide solution and examined in water and stored as above. The diagrams were drawn with the help of "Ocular square Reticule" placed in right eye piece of the stereoscopic dissecting binocular microscope. All the measurements are given in the millimeter. The scheme of measurement followed is that of (Hollis 1965).The terminology with regard to phallic complex and female genitalia is adopted from (Dirsh 1956).

Key to the Species and Sub Species of the genus Aiolopus Fieber recorded from Pakistan

1. Tegmina without distinct spots; hind femur more slender about five times longer than.Epiphallus with bridge wide extending towards the lateral plates, anterior projections broad with sub acute apices……*simulatrix simulatrix* Walker.

--Tegmina with distinct spots; hind femur heavier about four times longer than its maximum width. Epiphallus with bridge narrow, slightly curved outwardly……..2

2.Fronter ridge broad; pronotum much produced behined and obtusely angular apex Epiphallus with anterior projections well expanded with rounded boundries at apex, lateral plates with externo - terminal inflections; lophi laterally upwarded, having broad apical lobe. ---------- *thalassinusthalassinus*. Fabricius. -- Fronter ridge narrow; pronotum less produced behined and rounded apex Epiphallus with anterior projections lobe like , lateral plates straight, posterior projections broad and conical, lophi laterally straight with broad sub-conical apical lobe ……*thalassinus tamulus*. Fabricius.

Results and discussions

1) Aiolopus Simulatrix Simulatrix (Walker)

Diagnostic characters

Of small size. Antenna filiform , 22-24 segmented as long as head and pronotum together. Head sub conical shorter than pronotum. Fastigium of vertex pentagonal, slightly longer than wide, moderately concave with well defined margins; forward angles narrowly rounded. Fastigial foveolae trapezoidal; frontal ridge wide coarsely and densely pitted. Pronotum relatively narrow, median carina stronger in prozona than in metazona; lateral carinae absent. Tegmina and wings well developed. Hind femur broad. Hind tibia shorter than hind femur with 9 outer and 10 inner black tipped spines. Claws shorter. Arolium small.

Phallic Complex

Apical valve of penis longer than the valve of cingulum, sharpely tapered at the apex with rounded acute apices; valve of cingulum straight upwardly, slightly wide, oval rounded at apex. Arch of cingulum with furrow, apodemes is large, dorso-ventrally flattened; and produced anteriorly, having rounded club shaped process, zygoma short and wide, visible posteriorly into short lobes and with obtuse apices. Rami well developed, large extending into the sheath dorsally lobe like; with slightly denticulate marginal furrows. Gonopore processes long with truncated apices. Ejaculatory sac long, wide directed anteriorly. The epiphallus is attached to ninth sternite and to the zygoma by muscular tissues; epiphallus bridge shaped, bridge wide extending as for as the anterior plates anterior projections broad with sub acute apices, posterior projections with rounded externo- lateral expansions, lateral plates are eventually straight. Ancorae thick, broad at base, an drop like in form, slightly incurved,with acute apices at apex. Lophi

flattened, straight anteriorly with broad spherical apical lobes and sub conical, posterior projections ending in short oval rounded processes. Besides the lateral plates circular oval sclerites.

General Coloration

Generally brown with ochraceous or green and blackish markings; pronotum unicoloursly brown or green. Tegmina with two ochraceous transverse fasciae. Wings hyaline. Hind femur with two dark spots in upper outer area, inner side with two incomplete dark bands. Hind tibia narrowly black basally followed by broad ochraceous ring and with broad blackish ring medially, apical third reddish.

Distribution

Burma, India, Pakistan, Iran, Arabia, Turkey, East Africa, Egypt, and Tanzania.

Female

Cerci short, conical with obtuse apices. Ovipositor short; robust, valves curved.

Spermatheca

The pre –apical diverticulum, shorter, straight rounded at apex. Apical diverticulum sac like, smoothly dilated and rounded at base.

Table 1. Measurements in millimeters (mm).

Body Parameters	Male (n=7)		Female (n=9)	
	(Mean ± Sd)	(Range)	(Mean ± Sd)	(Range)
Length of Body	17.71 ±1.84	17-19	22.55 ± 2.04	22-24
Length of Antennae	4.57 ±1.29	4-5	6.55 ± .67	6-7
Length of Pronotum	2.42 ± 1.29	2-3	5.61±1.02	5.3-6
Length of Tegmina	18.57± 3.69	17-21	20.66 ± 1.41	20-21
Maximum width of Tegmina	2.28 ±1.17	2-3	3.21 ± 0.66	3.1-3.3
Length of hind Femur	8.35. ± 1.23	8-9	10.37 ± 1.31	11-0
Maximum width of hind Femur	2.27 ± 0.87	2-3	2.06 ± 0.43	2-2.1
Length of hind tibia	8.34 ±1.04	8-9	9.73± 2.27	9.2-10

Remarks

This subspecies is very closely related to *A. femoralis* Uvarov in having general body form but can easily be separated from the same in having the hind tibia shorter than hind femur with nine outer and ten inner spines, hind femur is less broad and tegmina will surpassing tip of hind femur and by the other characters as noted in keys and description.

Repository

The type material has been deposited in the Museum of Entomology, Department of Zoology, University of Sindh Jamshoro,Pakistan.

ii) *Aiolopus thalassinus thalassinus* (Fabricius)

Diagnostic characters

Of small size. Antennae filiform, about 22-24 segments slightly longer than head and pronotum together. Head sub –conical, smaller than pronotum. Fastigium of vertex angular,with lateral carinulae extended posteriorly to apices of eyes and bent inwards, projected over frons roundly. Fastigial foveolae trapezoidal; frontal ridge wide, flattened and punctuate. Pronotum slightly saddle shaped ,narrowed in prozona, median carina slightly projected in prozona; lateral carinae absent. Tegmina and wings fully developed. Hind femur long, dorsal carina not serrated, dorsal genicular lobes rounded. Hind tibia slender thin with 10 -11 black tipped spines on either sides. Claws shorter. Arolium small.

Phallic Complex

Apical valve of penis slightly longer than the vale of cingulum, dorsally plough like in shape, tapered and pointed at apex; valve of cingulum thickening, smaller

sub acute rounded at apex . Arch of cingulum well developed. Apodemes moderate, straight, thick directed anteriorly with rounded apices; zygoma remarkable with emarginated post margin. Rami flattened lobe like, extending into the sheath dorsally. Gonopore well marked thick at middle, with truncated apices. Ejaculatory duct large, produced anteriorly. The epiphallus bridge shaped, bridge narrow, straight. Anterior projections expanded with slightly rounded boundries at apex, lateral plates directed posteriorly and with externo-terminal expansions. Ancorae moderate, straight upwardly with rounded acute apices at apex, slightly widened, conical at base. Lophi diverging slightly from the lateral plates; laterally upward, directed anteriorly having broad apical lobes ending in small rounded terminal processes; besides the lateral plates circular oval sclerites.

General Coloration

Generally vary in colour,may be paler brown, greenish brown or dusty brown. Antennae brownish. Head reddish brown; fastigium green, brown or pink reddish. Tegmina semi transparent and brownish with irregular blackish speckles. Wings hyaline and colorless. Hind femur paler brown, along with ventral carina a longitudinal green band, inner side with 2-3 dark bands. Hind tibia has straw color, with median and apical black bands.

Distribution

Pakistan, India, Australia, France, Southwest Africa, Japan and SriLanka.

Female

Cerci short, conical with obtuse apices. Ovipositor short, robust,valves curved, ventral valve with lateral projection.

Spermatheca

The spermatheca with pre –apical diverticulum thick,shorter, straight rounded at apex apical diverticulumsac like, elongated,dilated smoothly rounded at base.

Remarks

This subspecies is very closely related to *A. meruensis* Sjosted in having antennae shorter than head and pronotum together but can easily be separated in having fastigial foveolae narrowly trapezoid and pronotum narrower and by other characters as noted in the keys and description.

Table 2. Measurements in millimeters (mm).

Body Parameters	Male (n = 30)		Female (n = 30)	
	(Mean ± Sd)	(Range)	(Mean ±Sd)	(Range)
Length of Body	15.86±3.34	15-17	22.46 ±5.60	21-25
Length of Antennae	5.75 ±2.50	5.5-6.7	5.73 ±2.99	5-7
Length of Pronotum	3.12 ±1.12	3.0-3.5	4.22 ±1.85	4-5
Length of Tegmina	17.9±6.68	17.5-21.0	22.1±7.52	20-24
Maximum width of Tegmina	3.26 ±2.05	3-4	4.18 ±2.52	4-4.3
Length of hind Femur	9.63 ±5.30	9-11	11.83±3.14	11-13
Maximum width of hind Femur	2.44 ±2.14	2-3	3.15±1.84	3 -4
Length of hind tibia	8.36 ±2.26	8-9	9.7±3.20	9-11

Repository

The type material has been deposited in the Museum of Entomology, Department of Zoology, University of Sindh Jamshoro, Pakistan.

iii)*Aiolopus thalassinus tamulus* (Fabricius)

Diagnostic characters

Of small size, Antennae long, filiform, about 22-24 segments, slightly longer than head and pronotum together . Head sub-conical, shorter than pronotum. Fastigium of vertex angular, median carinula absent, lateral carinulae extended to anterior margin of eyes with straight apices. Fastigial foveolae trapezoidal;

frontal ridge tapering gradually towards fastigium and with sharp margins.pronotum sub-saddle shaped,constricted in middle median carina well developed; lateral carinae absent. Tegmina and wings fully developed with obtuse rounded apices. Hind femur of medium size. Hind tibia slender with 10-11 black tipped spines. claws shorter. Arolium small.

Phallic Complex

Apical valve of penis nearly parallel to the valve of cingulum , tapered, pointed at apex; valve of cingulum shorter,thickening, slightly wide, sub acute and rounded at apex . Arch of cingulum well developed. Apodemes moderate, straight, directed anteriorly with rounded distal process, basal fold of bridge angular. Zygoma visible and bark like . Rami well developed extending into the sheath dorsally flap lobe like. Gonopore stout large. Ejaculatory sac large directed anteriorly. The epiphallus bridge shaped, bridge narrow, slightly curved outwardly, lateral plates straight upward directly. Anterior projections lobe like narrow with acute apices, posterior projections broad with conical terminal process. Ancorae large, rice grain like in form, straight upwardly with rounded acute apices at apex; slightly incurved at base. Lophi shoes like in shape, laterally straight, directed anteriorly having wide apical lobes; sub conical, ending into small rounded terminal processes; Besides the lateral plates circular oval sclerites.

General Coloration

Generally vary in the color; paler green, dusty or greenish. Tegmina transparent, with white and brown irregular scattered spots. Wings hyaline and transparent. Hind femur along the ventral carina on outer margin with black dots. Hind tibia reddish or in some paler with one or two small black bands.Distribution:Pakistan, India, SriLanka, Australia, France, and Southwest Africa and Japan.

*Female :*Cerci short and conical. Ovipositor short, robust, valves stout with curved apices.

Table 3. Measurements in millimeters (mm).

Body Parameters	Male (n=20)		Female (n=20)	
	(Mean ± Sd)	(Range)	(Mean ± Sd)	(Range)
Length of Body	22.45 ±5.90	21-25	23.3 ±6.49	24-26
Length of Antennae	4.25 ±1.51	4-5	5.26 ±1.71	5-6
Length of Pronotum	4.31 ±1.79	4-5	4.44±1.26	4-5.3
Length of Tegmina	20.2 ± 4.14	19-22	21.25±1.73	21-22
Maximum width of Tegmina	3.49 ±3.20	3-5	4.07± 1.03	4.1-4.3
Length of hind Femur	11.8 ±2.68	11-13	12.72±1.03	12.5-13
Maximum width of hind Femur	3.22 ±1.57	3-4	3.52± 1.74	3-4
Length of hind tibia	9.85 ±3.24	9-11	10.27±1.74	10-11

Spermatheca

The spermatheca with pre-apical diverticulum small, thickening slightly denticulate at apex. Apical diverticulum sac like conical, elongated and spherical at base.

Remarks

This subspecies is very closely related to *A.thalassinus thalassinus* and can be distinguish by the characters given in the keys and description. *Aiolopus thalassinus tamulus* is less abundant as compared to *A.thalassinus thalassinus*.

Repository

The type material has been deposited in the Museum of Entomology, Department of Zoology, University of Sindh Jamshoro,Pakistan.

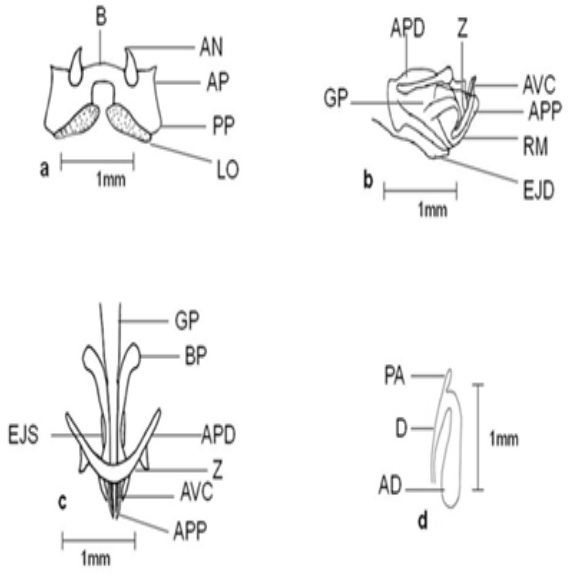

Fig. 1. Aiolopus simulatrix simulatrix , genitalia. a) Epiphallus. b) Endophallus and Cingulum lateral view. c) Same dorsal view. d) Spermatheca.

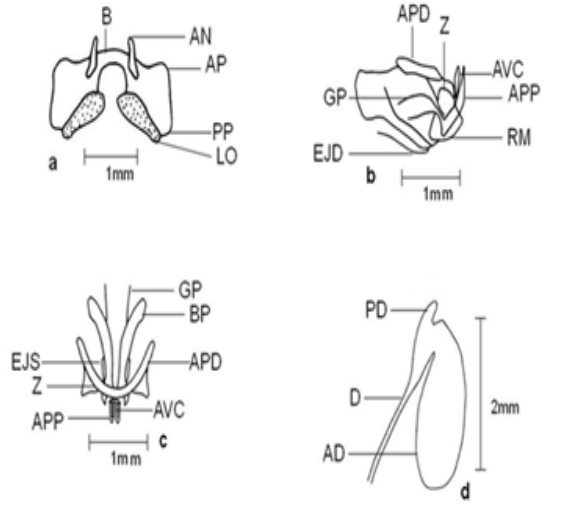

Fig. 2. Aiolopus thalassinusthalassinus ,genitalia. a) Epiphallus. b) Endophallus and Cingulum lateral view. c) Same dorsal view. d) Spermatheca.

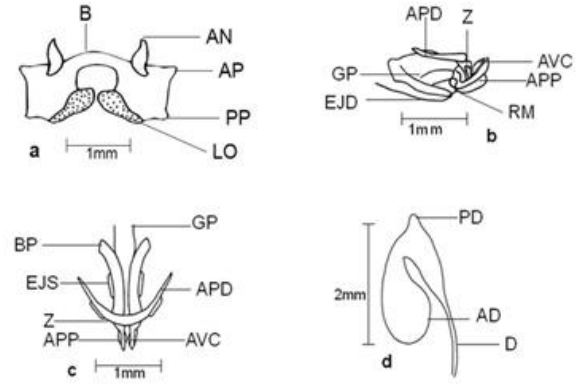

Fig. 3. Aiolopus thalassinustumulus ,genitalia.a) Epiphallus. b) Endophallus and Cingulum lateral view .c) Same dorsal view.d) Spermatheca .

(a) (b) (c)

Fig. 3. (a) *Aiolopus simulatrix simulatrix* Walker (Male); **(b)** *Aiolopus thalassinus thalassinus*

Fabricius (Male); **(c)** *Aiolopus thalassinus tamulus* Fabricius (Male)

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